

# Roundabouts at Diamond Interchanges



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# INTRODUCTION

- Diamond Interchanges
  - Urban Areas – to provide grade separations at high volume intersections
  - Rural Areas – to provide access
  - Fail due to increase in volumes at the ramps



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# INTRODUCTION (cont.)

- Roundabout Interchanges
  - Provides higher capacity than conventional diamond interchanges
  - Longer life to the interchange before adding lanes or widening the bridge
  - Safer operation



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# SCOPE

- Type of Interchanges
  - Conventional Diamond Interchange
  - Single Lane Roundabout Interchange
- Comparison Parameters
  - Safety
  - Construction Cost
  - Capacity/Operations





# METHODOLOGY

- Site Selection

- I-40 and NC 751 Interchange in Durham County
- I-85 and Churton Street Interchange in Orange County
- I-485 and Moores Chapel Road in Mecklenburg County
- US 23-74 and Hyatt Creek Road Interchange in Haywood County
- US 64 and SR 1209 (Road St.) Interchange in Tyrell County
- US 64 and SR 1310 (Sixth St.) Interchange in Washington County



# METHODOLOGY

- Software
  - *Synchro Version 7*
  - *SimTraffic Version 7*
  - *VISSIM Version 4.10*
  - *aaSIDRA Version 2.1*
- Interchange Configurations
  - Diamond Interchange with Signals at Ramps
  - Diamond Interchange with Stop control at Ramps
  - Diamond Interchange with Roundabouts at Ramps



# METHODOLOGY (cont.)

- Comparisons
  - Safety – Number of Crashes based on general statistics
  - Construction Costs – Estimates provided by NCDOT
  - Capacity/Operation – Measures of Effectiveness



# RESULTS - SAFETY

- Safety
  - Not enough statistical data at the time of this study
  - Results based on general studies all over USA\*
- Summary
  - Comparative studies indicate that roundabouts reduce crash rates
  - Reduces crash severity due to low operating speeds
  - Modified teardrop shape prevents wrong way movements
  - One way ramp alignment reduces wrong way crashes

\* Results are not based on data collected at the interchanges listed



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# RESULTS - SAFETY

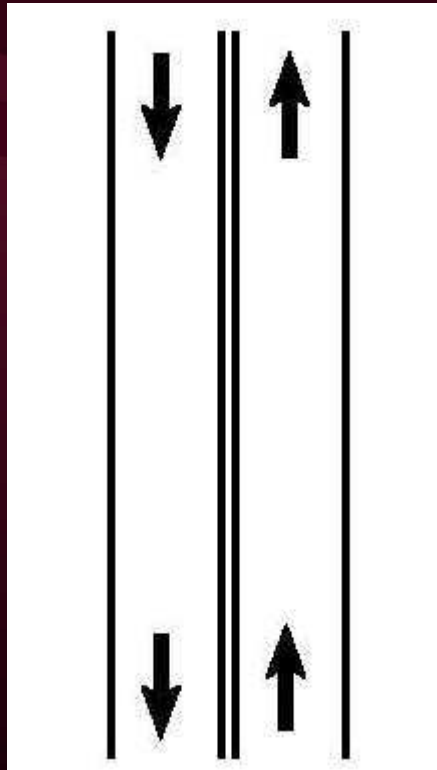


**I-40 and NC 801, Davie County, North Carolina**

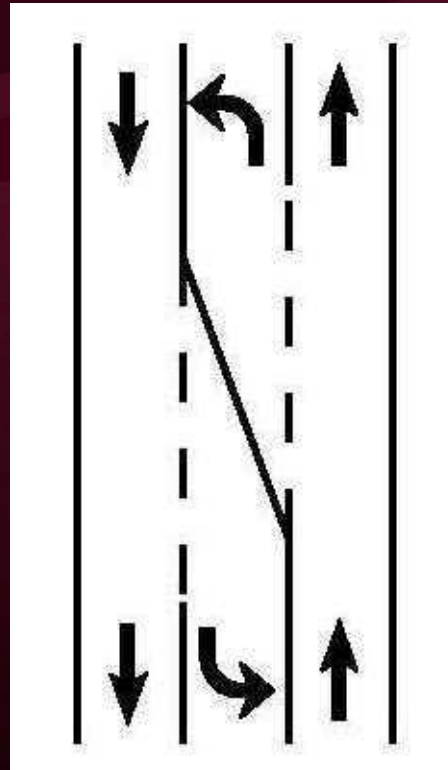


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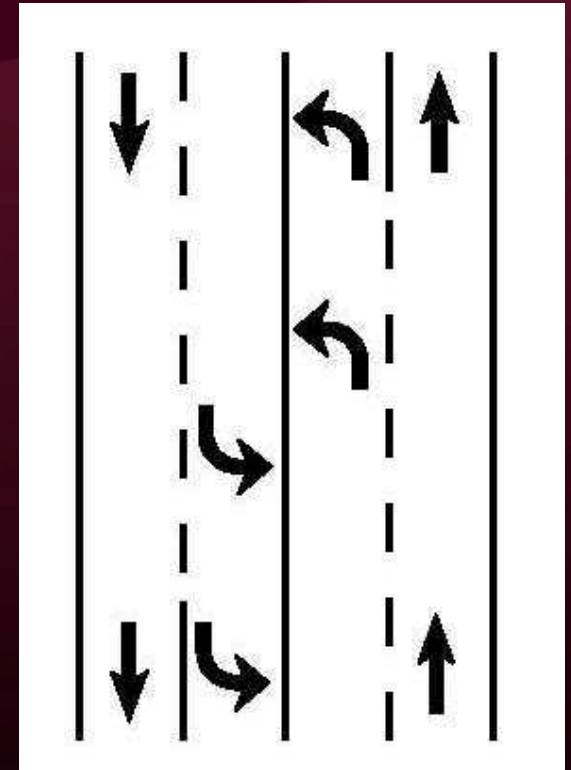
# RESULTS – CONSTRUCTION COST



**TWO-LANE  
BRIDGE  
STRUCTURE**



**THREE-LANE  
BRIDGE  
STRUCTURE**



**FOUR-LANE  
BRIDGE  
STRUCTURE**



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# RESULTS – CONSTRUCTION COST (cont.)

INTERCHANGE CONFIGURATION	Construction Cost in USD (as of 2006)
Diamond Interchange with <b>STOP</b> control at the ramp terminals and a <b>TWO</b> lane bridge structure	\$ 2,000,000.00
Diamond Interchange with <b>ROUNDABOUT</b> control at the ramp terminals and a <b>TWO</b> lane bridge structure	\$ 2,500,000.00
Diamond Interchange with <b>SIGNAL</b> control at the ramp terminals and a <b>THREE</b> lane bridge structure	\$ 2,900,000.00
Diamond Interchange with <b>SIGNAL</b> control at the ramp terminals and a <b>FOUR</b> lane bridge structure	\$ 3,450,000.00





# RESULTS - OPERATIONS

INTERCHANGE	SELECTED DIAMOND INTERCHANGE CONFIGURATION
I 40 and NC 751	Signal Control and Four Lane Bridge
I 85 and Churton Street	Signal Control and Three Lane Bridge
I 485 and Moores Chapel Road	Signal Control and Three Lane Bridge
US 23-74 and Hyatt Creek Road	Signal Control and Three Lane Bridge
US 64 and Road Street	Stop Control and Two Lane Bridge
US 64 and Sixth Street	Stop Control and Two Lane Bridge



# RESULTS – OPERATIONS (cont.)

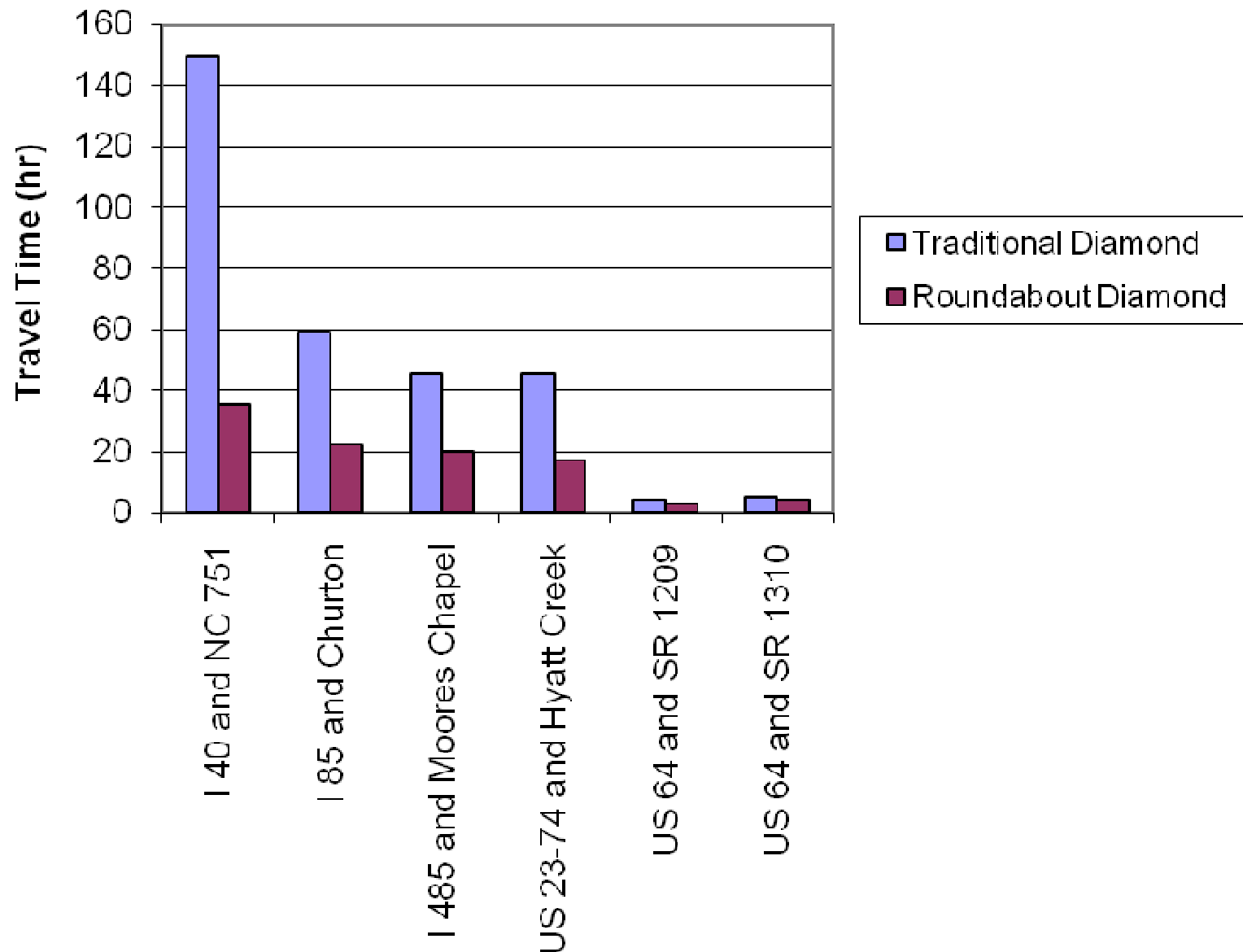
- Two ways of Comparison
  - Individual Movements/Intersection – Detailed
  - Network Performance/Interchange – Overall
- Measures of Effectiveness – Network
  - Travel Time
  - Average Speed
  - Total Delay
  - Total Stops

\*Limited to Network Performance in this presentation



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# RESULTS – OPERATIONS (cont.)



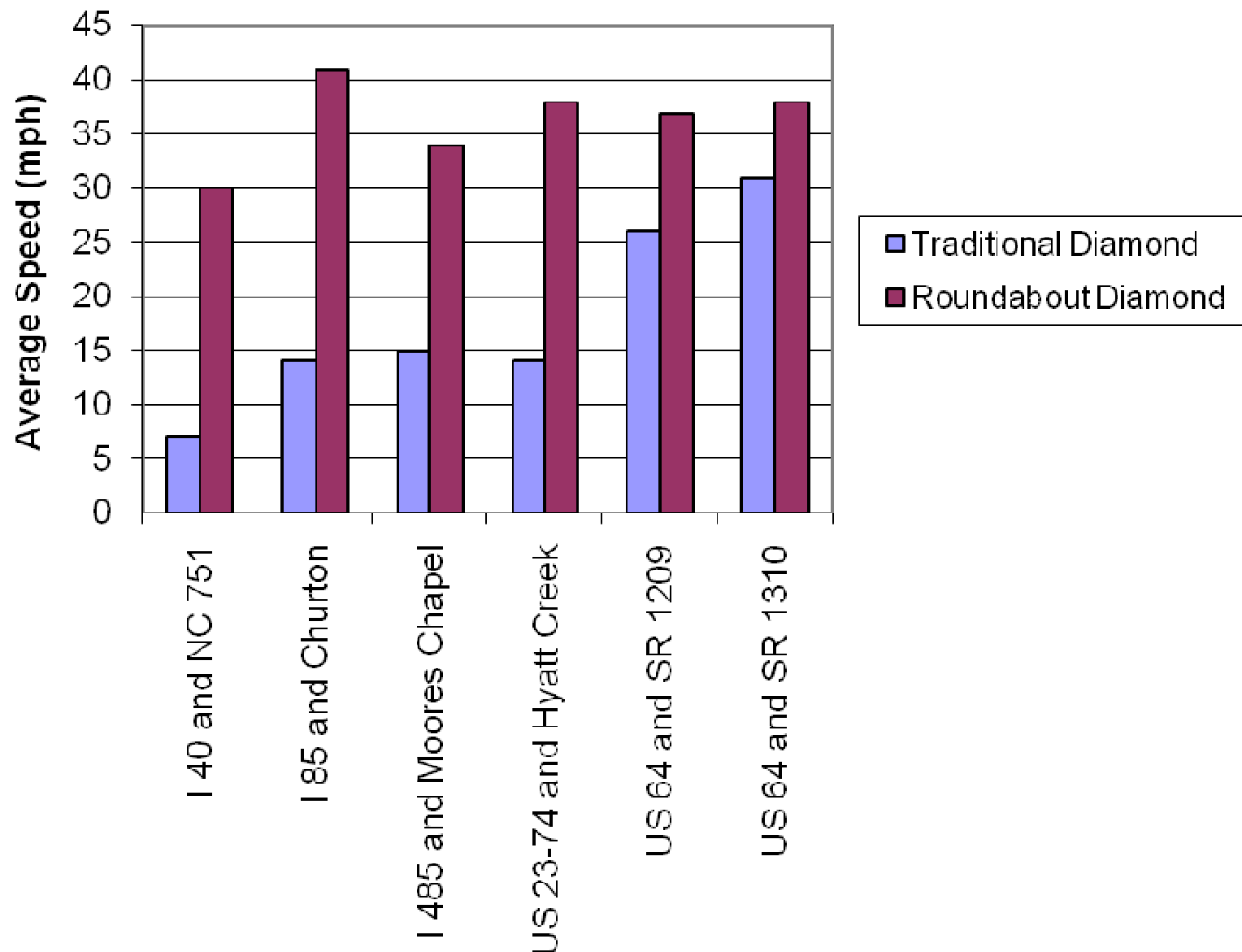
**SYNCHRO: TRAVEL TIME COMPARISON**



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# RESULTS – OPERATIONS (cont.)

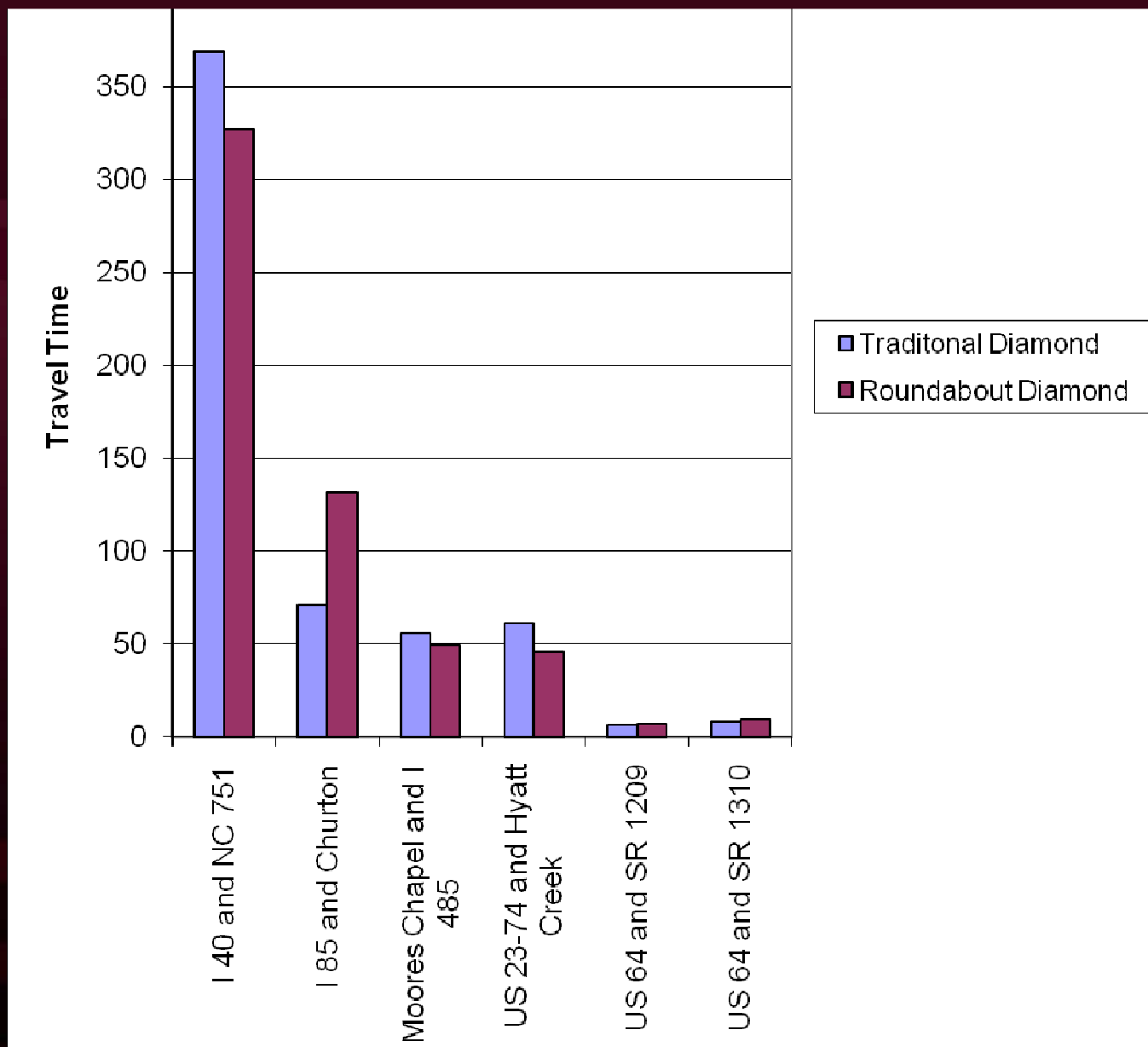


## SYNCHRO: AVERAGE SPEED COMPARISON



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# RESULTS – OPERATIONS (cont.)

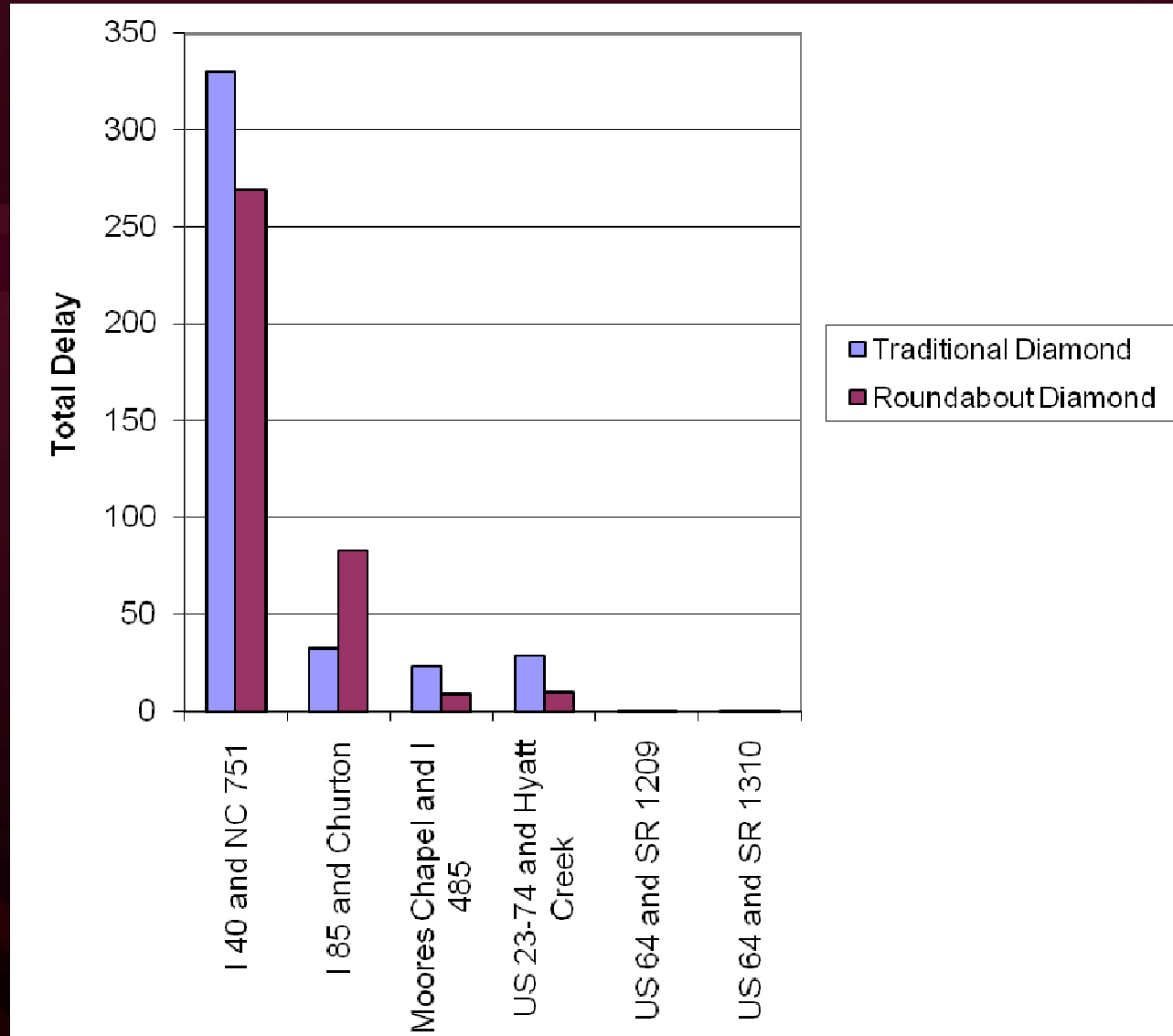


**SIMTRAFFIC: TRAVEL TIME COMPARISON**



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# RESULTS – OPERATIONS (cont.)



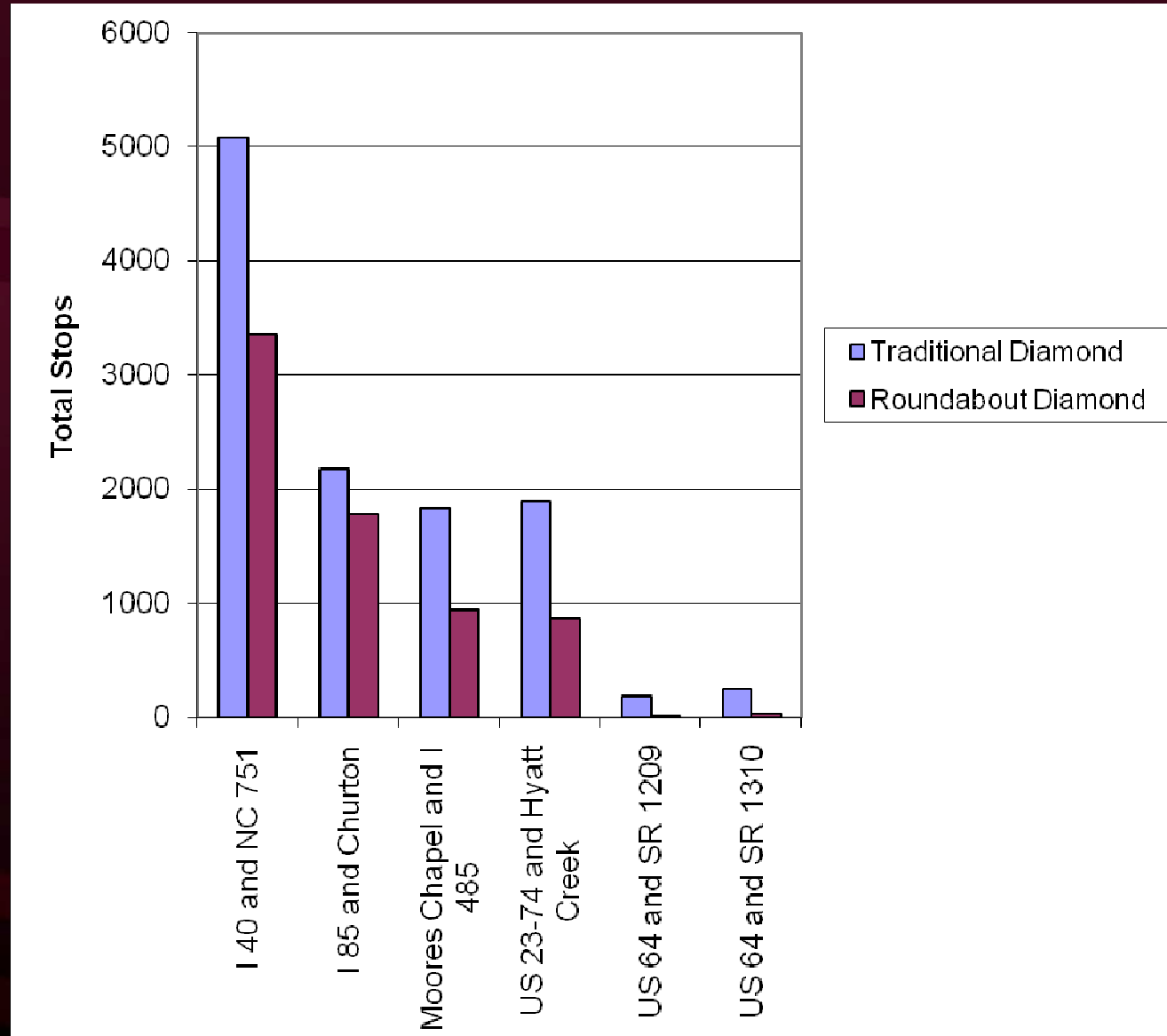
**SIMTRAFFIC: TOTAL DELAY COMPARISON**



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# RESULTS – OPERATIONS (cont.)

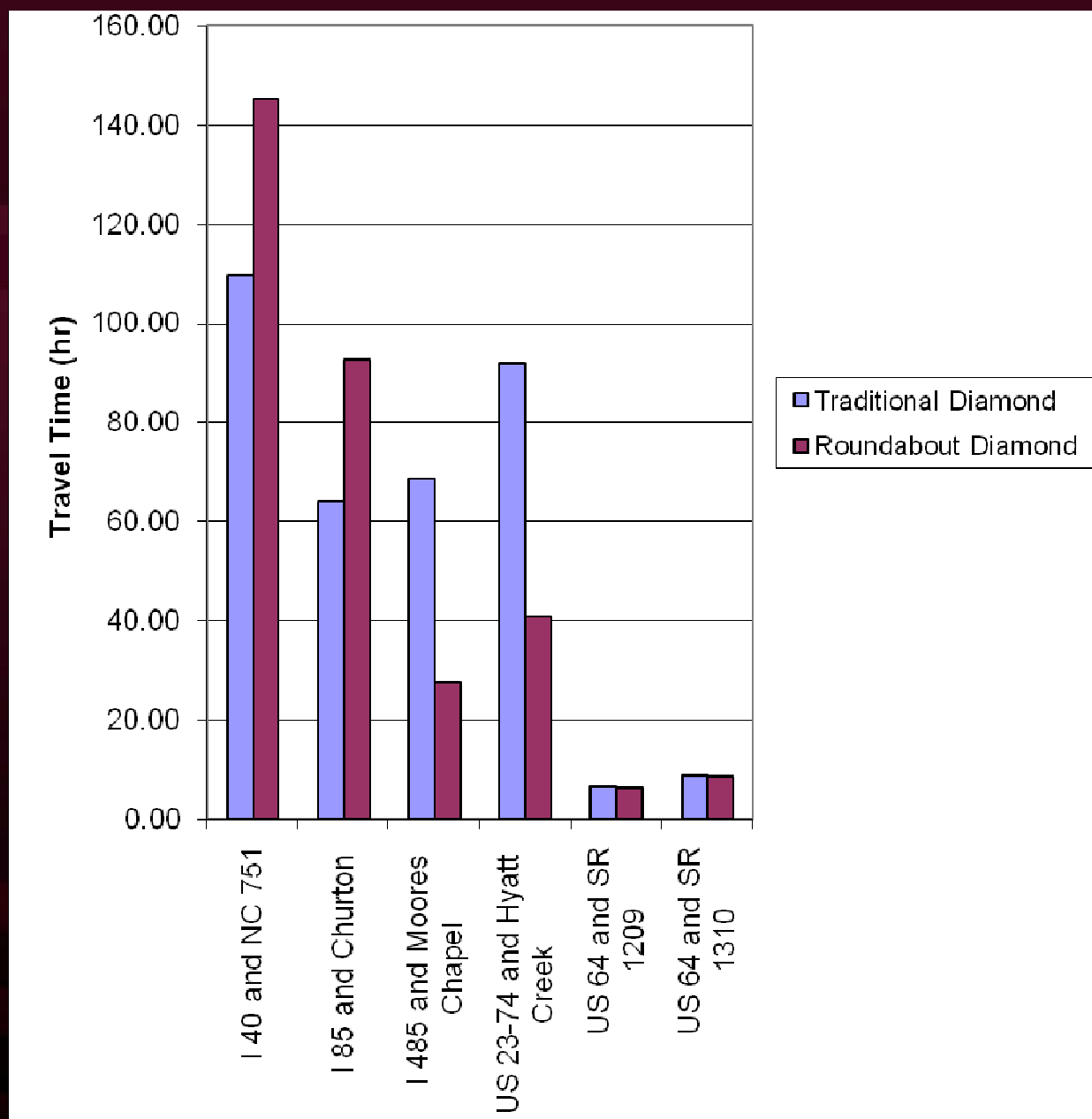


## **SIMTRAFFIC: TOTAL STOPS COMPARISON**



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# RESULTS – OPERATIONS (cont.)

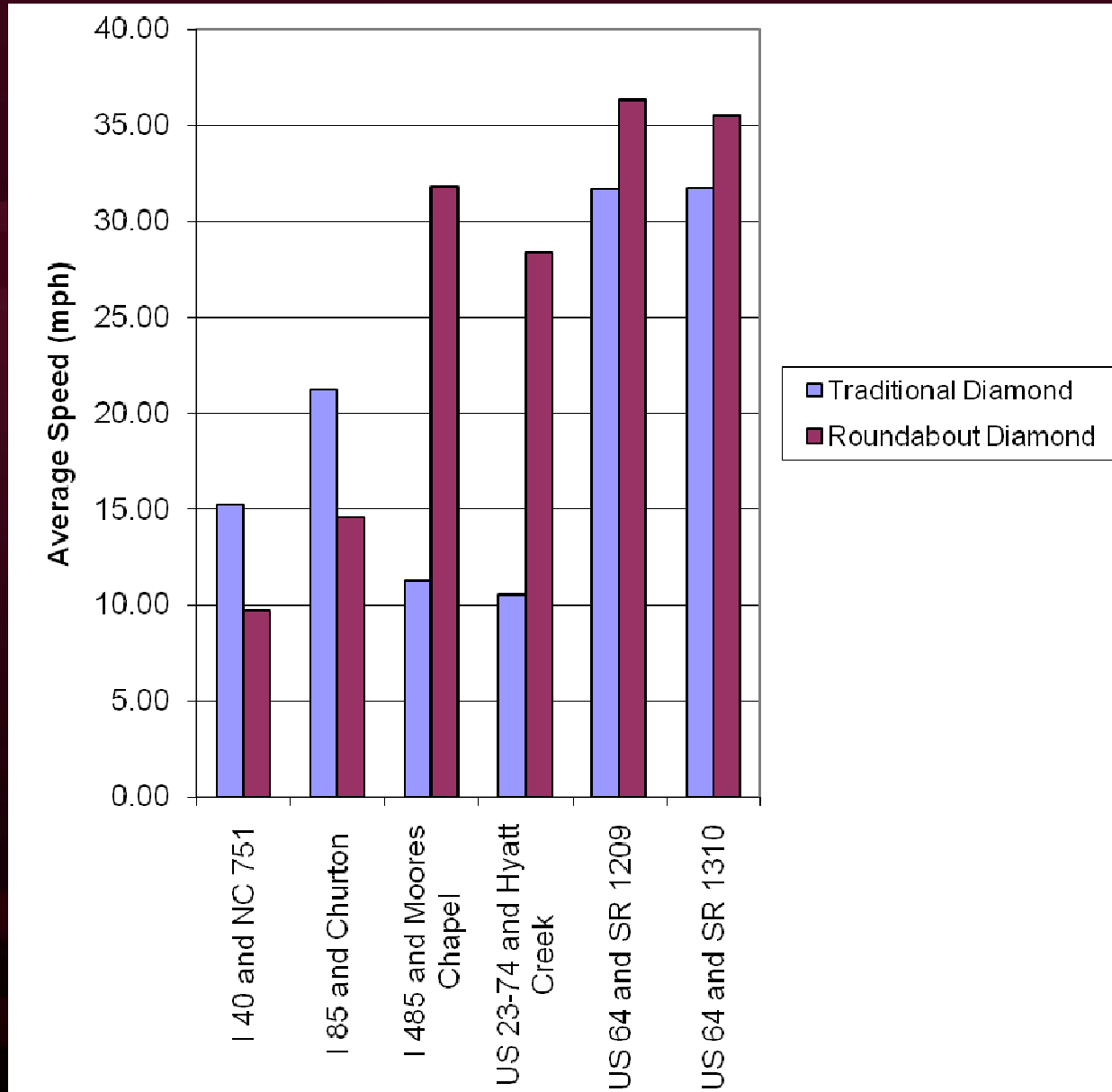


**VISSIM: TRAVEL TIME COMPARISON**



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# RESULTS – OPERATIONS (cont.)



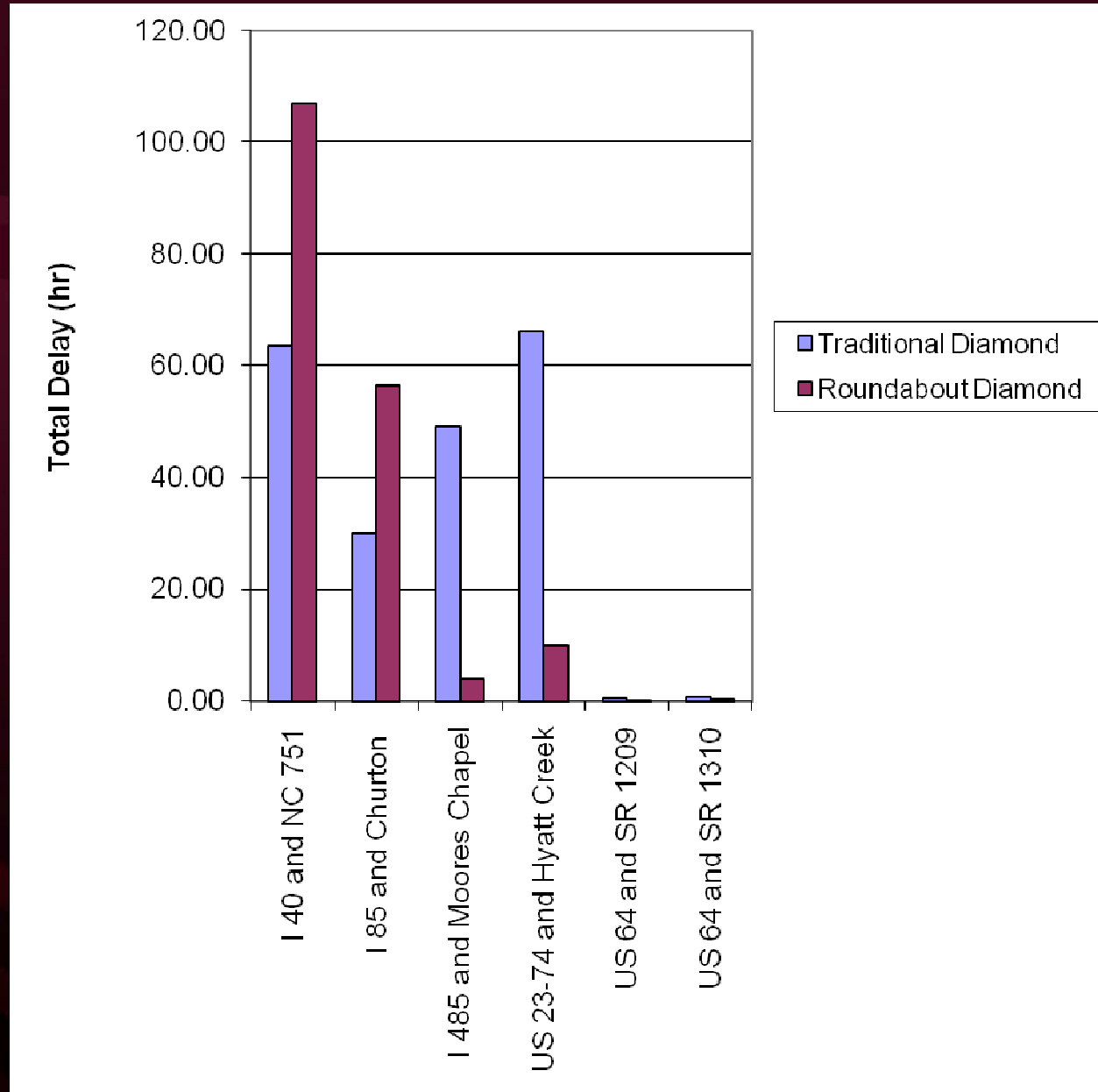
**VISSIM: AVERAGE SPEED COMPARISON**



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# RESULTS – OPERATIONS (cont.)

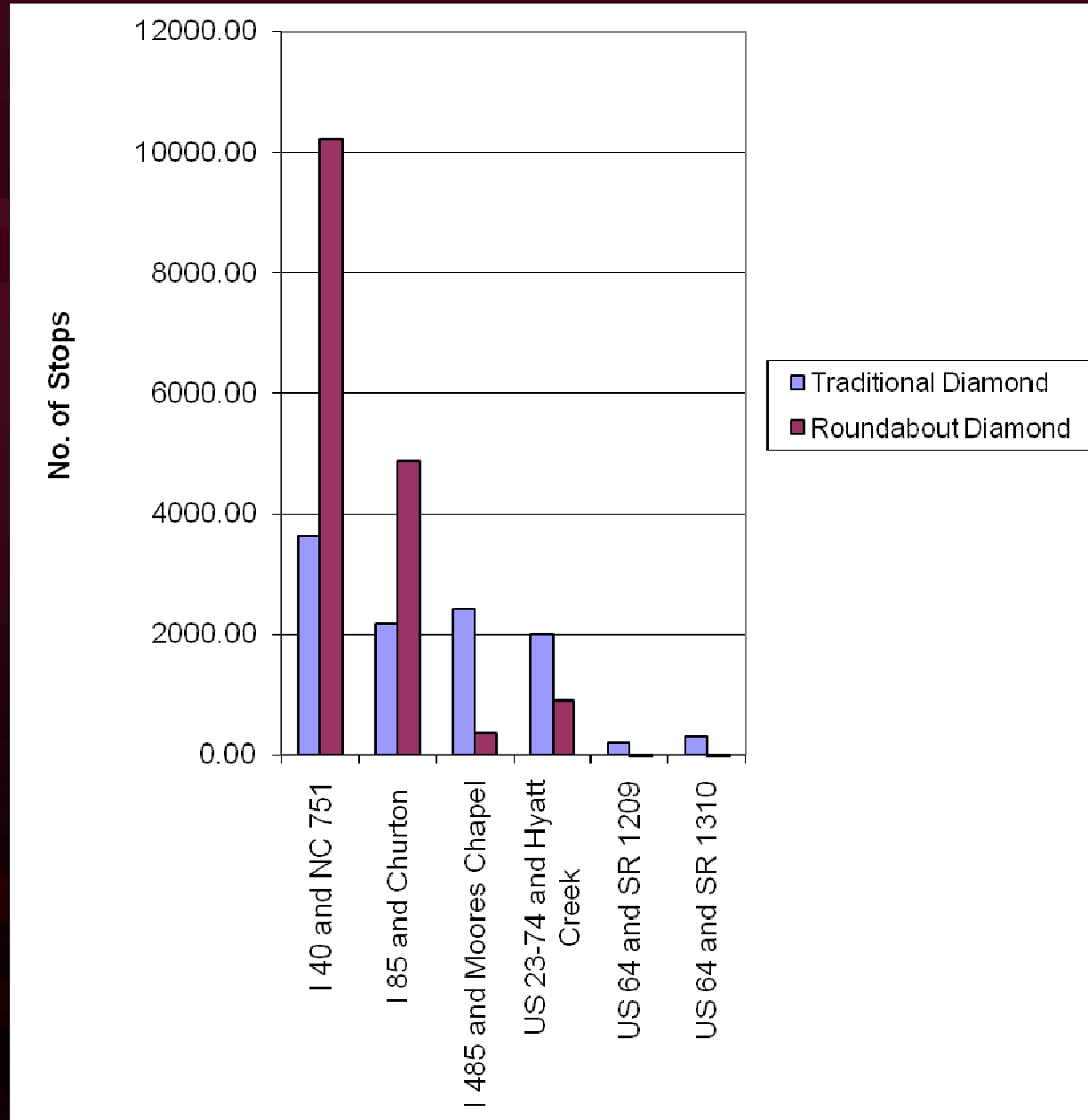


**VISSIM: TOTAL DELAY COMPARISON**



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# RESULTS – OPERATIONS (cont.)



**VISSIM: TOTAL STOPS COMPARISON**



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# RESULTS – OPERATIONS (cont.)

- *aaSIDRA 2.1*
  - Limited to Individual Intersection/Movements data
  - No Network Performance comparison available



# CONCLUSIONS – SAFETY

- Studies show that roundabouts have lower crash rates over other controls
- Roundabouts can reduce the possibility of wrong way crashes
- Roundabouts reduce the severity of crashes due to low operating speeds



# CONCLUSIONS – COST

- Roundabout interchanges are less expensive compared to signalized diamond interchanges
- Roundabout interchanges increase the life of the interchange before adding turn lanes or additional through lanes





# CONCLUSIONS – CAPACITY

- Software

- Synchro/SimTraffic not recommended for roundabout analysis
- VISSIM provided reasonable results but needs detailed programming
- aaSIDRA provided reasonable results with simple programming, but can only analyze isolated intersections



# CONCLUSIONS – CAPACITY

- I-40 and NC 751 Interchange
  - Operates poorly due to high volumes
  - Two-lane roundabout interchange??
- I-85 and Churton Street Interchange
  - Operates acceptably at Northbound Ramp
  - Operates poorly at Southbound Ramp



# CONCLUSIONS – CAPACITY

- I-485 and Moores Chapel Road Interchange
  - Operates better with Roundabouts
  - Significant reduction in Travel Time, No. of Stops, and Delay and increase in Average Speed
  - Provides longer life span
  - Existing Roundabout Interchange



# CONCLUSIONS – CAPACITY

- US 23-74 and Hyatt Creek Road Interchange
  - Operates better with Roundabouts
  - Significant reduction in Travel Time, No. of Stops, and Delay and increase in Average Speed
  - Provides longer life span
  - Currently Partial Roundabout Interchange



# CONCLUSIONS – CAPACITY

- US 64 Interchanges at Road St. and Sixth St.
  - Operate with either less or equal delay and travel time
  - Roundabouts reduce the no. of stops hence reducing fuel emissions
  - At very low volumes, delay is due to traveling around the Roundabout
  - Provides longer life span over stop control





# RECOMMENDATIONS

- Roundabout Interchange performs better when there are high left-turning volumes
- Roundabouts with heavy right-turn volumes do not provide as strong a benefit
- Individual movements should be emphasized in Capacity Analysis



# RECOMMENDATIONS

- Both Stop Control and Roundabout intersections perform well at low volume interchanges
- However, installing roundabouts instead of stop control may reduce no. of stops, address potential safety issues and provide longer life span

